Platte River Basin

Table of Contents

Watershed Description

Three of the nation's major river systems have their headwaters in Wyoming: the Missouri, Colorado, and Columbia Rivers. These watersheds provide a natural basis for delineating aquatic conservation areas. Six major watersheds were identified for conservation planning purposes under this State Wildlife Action Plan (SWAP) using hydrographic boundaries and fisheries assemblage and management considerations (Figure 7). These areas are consistent with the aquatic ecosystems identified for freshwater biodiversity conservation worldwide by Abell et al. (2008). The watershed areas are also synonymous with aquatic zoogeographical units and ecological drainage units identified under The Nature Conservancy's (TNC) hierarchical classification framework (Higgins et al. 2005). The watersheds each include one to four sub-regions (4-digit hydrologic unit code [HUC] watersheds). This approach allows the nesting of multiple spatial and temporal scales for planning and prioritizing conservation actions.

The Platte River Basin is based on, and exactly corresponds with, two 4-digit HUC watersheds: North Platte and South Platte. Major drainages in the North Platte River basin corresponding to 8-digit HUCs include the Upper North Platte, Pathfinder-Seminoe Reservoir, Medicine Bow, Little Medicine Bow, Sweetwater, Middle North Platte-Casper, Glendo Reservoir, Middle North Platte-Scotts Bluff, Upper Laramie, Lower Laramie, Horse, and a minor piece of Pumpkin basin. In the South Platte, major drainages with portions in Wyoming include Cache la Poudre, Lone Tree-Owl, Crow, Upper Lodgepole, Lower Lodgepole, and Sidney Draw. These watersheds span about one quarter of Wyoming, covering 24,200 square miles in southeastern and central Wyoming's Albany, Carbon, Converse, Fremont, Goshen, Laramie, Natrona, Niobrara and Platte counties. Land ownership is predominantly private (62%). Public land in this basin is managed primarily by the Bureau of Land Management (22%), U.S. Forest Service (9%), and the State of Wyoming (8%).

The North Platte River enters the state from Colorado at an elevation of about 7,740 feet and flows for about 350 miles before leaving the state to flow into Nebraska at an elevation of 4,025 feet. By volume, the river is the state's fifth largest, leaving the state with an average flow of about 1,950 cubic feet per second (cfs) (Wyoming State Geologic Survey, 2010). The river is free flowing from the headwaters in Colorado through the upper 119 Wyoming river miles from the Colorado state line to Seminoe Reservoir. Major main channel reservoirs, from upstream to downstream, are: Seminoe, Kortes, Pathfinder, Alcova, Glendo and Guernsey Reservoirs. Major tributaries include the Encampment River, Medicine Bow River, Laramie River and Sweetwater River (Figure 7). From an analysis of the 2010 Version 2.0 National Hydrological Database (NHD) at 1:100,000, there are approximately 23,450 miles of streams in the North Platte River basin in Wyoming. This equates to a drainage density of about 1.0 stream mile per square mile land area. About 78% of these stream miles are first or second order streams.

Four terrestrial-based ecoregions, as defined originally by Bailey (1995) and adapted by The Nature Conservancy, occur in the Platte River basin in Wyoming: Wyoming Basins, Southern Rocky Mountains, Central Shortgrass Prairie and Northern Great Plains Steppe. These delineations reflect the diversity of conditions where prairie predominates in the east and southeast, contrasting with the mountainous southern portion of the Wind River Range, Laramie Range, Sierra Madre Range, Medicine Bow Range, Ferris Mountains, Seminoe Mountains, and Shirley Mountains. Elevations range from 12,228 feet at the headwaters of the Sweetwater River in the southern Wind River Range, to 4,025 feet where the North Platte River departs the state. Relative to the Rocky Mountains to the south and west, these mountain ranges have moderate elevations where Medicine Bow Peak in the Medicine Bow

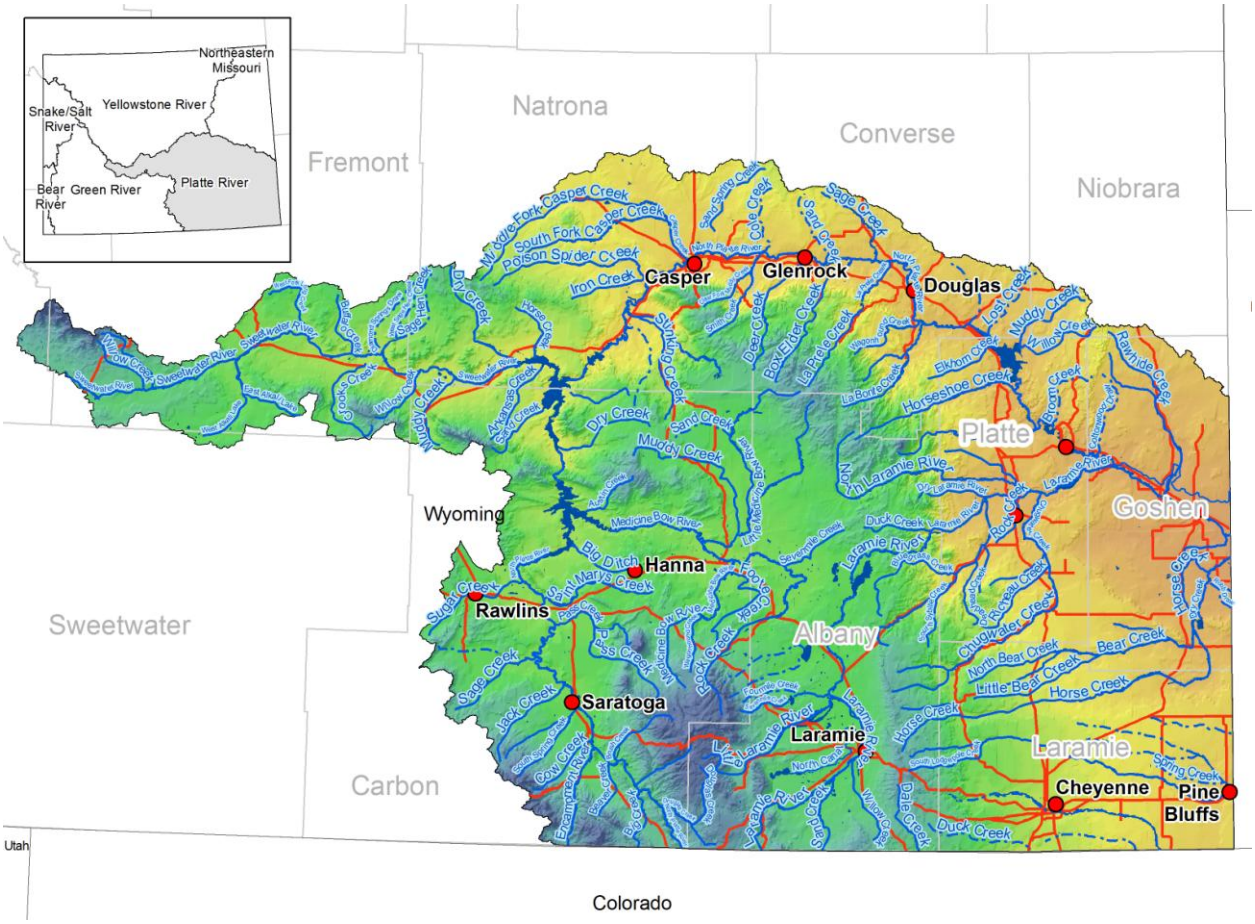

Figure 7. Platte River Basin.

Range is 12,013 feet, Bridger Peak in the Sierra Madre is 10,965 feet, and Laramie Peak in the Laramie Range is 10,276 feet. These peaks feed a snow-melt dominated pattern of water runoff. High basins, like the distinctive Laramie basin and Shirley basin, are unglaciated and largely flat with some rolling hills (Chapman et al. 2004). In these basins, nearly flat floodplains prevail with terraces and rolling alluvial fans and moderate gradient streams with riffle-run habitat features and cobble or smaller substrates (Chapman et al. 2004). Mountain glacial activity created high level erosional features in the Medicine Bow and Sierra Madre Mountains including Libby Flats and the valleys of many of the streams and rivers including Rock Creek and the Medicine Bow River (Bartos et al. 2006).

The structural basins and variety of granitic and sedimentary uplifts and mountains were formed during the Laramide orogeny and characterize the geology of the basin (Bartos et al. 2006; Lageson and Spearing 1988). Broad deposition across the eastern face of the Rocky Mountains and into the plains occurred in the late Eocene Epoch, filling basins and burying mountains. This surface eroded as uplift occurred in the Miocene Epoch and the beginnings of today's drainage networks were established (Bartos et al. 2006). A striking result of this deposition and uplift geologic history are cases where rivers cut directly through mountain ranges such as at Devil's Gate on the Sweetwater River. Here, the Sweetwater River cut a narrow gorge through the uplifting Granite Mountains and yet today it appears the natural course of the river could easily have avoided the rocky ridge by meandering a short distance south. Likewise, the North Platte River created Fremont Canyon downstream from today's Pathfinder Dam.

The Platte River basin largely overlaps Wyoming's climate divisions 8 and 10 (Curtis and Grimes 2004). Climate division 8, in the southeast, is one of the warmest of the 10 climate divisions in Wyoming, especially during fall through winter. Monthly temperatures range from an average of about 25º F in January, the coldest month, to about 70º F in July. Climate division 10 is about average for the state, with a January mean temperature of 20º F and July average of about 65º F (Curtis and Grimes 2004). Monthly precipitation for both climate divisions is lowest in December and January and highest in May. Much of the basin receives 8–12 inches of precipitation annually while downstream areas receive 12–16 inches annually (Platte River Basin Water Plan 2006). Maximum annual precipitation in the basin occurs as snow at high elevations and is over 50 inches at high-elevation Sierra Madre and Snowy Range National Resources Conservation Service Snowpack Telemetry (SNOTEL) sites (NRCS 2010).

Main channel North Platte water bodies include Seminoe Reservoir (1,017,000 acre feet (af) storage capacity), Kortes Reservoir (4,740 af), Pathfinder Reservoir (1,017,000 af), Alcova Reservoir (184,000 af), Gray Reef Reservoir (1,760 af), Glendo Reservoir (517,000 af), and Guernsey Reservoir (46,000 af). Laramie River sub-basin reservoirs over 5,000 af include Wheatland No. 2 (98,000 af), Grayrocks Reservoir (104,000 af), Wheatland No.3 Reservoir (80,000 af), and Lake Hattie Reservoir (60,000 af) (Platte River Basin Water Plan 2006). Other larger reservoirs include Hawk Springs Reservoir in the Horse Creek sub-basin, Granite and Crystal Reservoirs in the South Platte sub-basin, Hog Park Reservoir in the Sierra Madre Range, and Rob Roy Reservoir in the Medicine Bow Range. Construction on the North Platte Reservoirs began in 1905 at Pathfinder Dam and essentially reached its current configuration in 1961 when Gray Reef Dam was completed (Platte River Basin Water Plan 2006). Grayrocks Dam, on the lower Laramie River, became operational in 1978.

Miller (2003) delineated six hydrologic regions in Wyoming on the basis of peak flow characteristics. Much of the Platte River basin in the headwaters is in the Rocky Mountains Region under this delineation. As such, streams experience snow-melt runoff and have consistently high peak flows in late spring and early summer. With the exception of the Sweetwater River which occurs in the High Desert Hydrologic Region, remaining portions of the Platte River basin coincide with the Eastern Basins and Eastern Plains Hydrologic Region of Miller (2003). These regions have relatively high annual peak flows caused by moderate to intense rainstorm events (Miller 2003). Year-to-year variability in peak flows is high in the Eastern Basins and Eastern Plains Hydrologic Region. Many ephemeral and intermittent streams occur, particularly those draining the Laramie Range or originating within the various sub-basins.

Water development is extensive in the Platte River basin and plays a large role in patterns of stream flow. For example, the North Platte is highly controlled by dam releases for hydropower, irrigation, flood control, and municipal use. Irrigation diversions and trans-basin diversions further influence water supply. In the South Platte portion of the basin, sandy soils and low elevation headwaters result in naturally low and ephemeral flows in the prairie streams such as Crow Creek and Lodgepole Creek as they cross the prairies to the east.

All 11 habitat types defined in this SWAP (e.g., sagebrush shrublands, riparian, etc.,) occur in the watershed and are based on combinations of Ecological Systems (ES) developed by NatureServe (Comer et al. 2003, NatureServe Explorer 2009). The determination and delineation of ES is based on land cover maps produced by the Northwest Gap Analysis Project (NWGAP 2010). Land cover mapping under NWGAP for the Platte River basin would overlap USGS mapping zones 22 (Wyoming Basins) and 29 (Northern Rocky Mountains). Of the 173 ES identified under NWGAP, 72 occur in the Platte River basin (excluding developed and open water classes). The most

prevalent two classes, which are about equally represented, are the Inter-Mountain Basins Big Sagebrush Steppe and the Northwestern Great Plains Mixed Grass Prairie. Similarly, the most common SWAP habitats are sagebrush shrublands (37%) and prairie grasslands (28%). Wetlands are more abundant in this basin than any other in Wyoming and comprise 8.5% of the area. Associated species assemblages, threats, and conservation actions of these and other habitats in this watershed are addressed in separate SWAP chapters.

Land use is incredibly diverse in the Platte River basin. Livestock grazing on open range predominates in the public land portions, particularly in the western portions of the basin managed by the Bureau of Land Management (BLM) Rawlins and Casper District Offices. Resource Management Plans (RMPs) for these districts describe land management direction, resources and allocation of uses (Bureau of Land Management 2007, 2008). Timber production was historically important in the Medicine Bow National Forest while today the forests are experiencing massive amounts of dead or dying timber from mountain pine beetle infestations. In the upper North Platte River basin, tie drives were common and generally straightened stream channels and removed woody materials and obstructions. Mineral development is historically and presently substantial and spans the spectrum from gold and copper mining in the Sierra Madre, to gravel, oil, natural gas, coal, uranium, and recently wind development. Irrigated acreage throughout the basin is primarily directed toward livestock forage with hay, alfalfa, and pasture lands where conditions allow (Platte River Basin Water Plan, 2006). Eastern counties, particularly Laramie County, have relatively more dry land farming of winter wheat and beans. Goshen County in the east is agriculturally most diverse with relatively higher levels of sugar beets, corn and grain crops.

Irrigation is almost exclusively via flood irrigation application, although localized areas of heavier sprinkler use occur especially in Laramie County and around the community of Wheatland. The largest municipalities in Wyoming occur in the Platte River basin, including Cheyenne, Casper, Laramie, Douglas, Wheatland, Torrington, Saratoga, Rawlins, and Pine Bluffs. Municipal water use is often from a combination of surface and groundwater sources (Platte River Basin Water Plan, 2006). Cheyenne's water comes from drainages in the Medicine Bow and Laramie Mountains. Within the Laramie Mountains, Cheyenne obtains surface water from the North and Middle Forks of Crow Creek and stores this water in Granite, Crystal, Upper North Crow, and Old North Crow Reservoirs. Water from these reservoirs is piped to water treatment plants. In the Medicine Bow Mountains, Cheyenne obtains surface water from Douglas Creek and several tributaries through an inter-basin water exchange whereby water is diverted via pipelines and a tunnel from the Little Snake drainage of the Colorado River basin to Hog Park Creek and Hog Park Reservoir. Hog Park Creek is a tributary to the Encampment and North Platte Rivers. In exchange for this water delivery into the Platte River basin from the Little Snake drainage, Cheyenne diverts surface water from Douglas Creek and its tributaries below Rob Roy Reservoir and pipes that water by gravity to Cheyenne through Lake Owen and the Laramie Range reservoirs (Platte River Basin Water Plan, 2006).

Several waters in the basin are designated by the Wyoming Department of Environmental Quality (DEQ) as class 1, recognizing their outstanding features and protecting them from water quality degradation (Wyoming Department of Environmental Quality, 2001). These waters include the North Platte River from the Colorado state line downstream to the confluence with Sage Creek, North Platte River from Kortes Dam downstream to Pathfinder Reservoir ("Miracle Mile"), North Platte River from Alcova Dam downstream to Goose Egg Bridge, Sweetwater River above Alkali Creek, and the Encampment River from the Colorado state line downstream to the National Forest Boundary.

Mirroring the variable underlying geology, landforms and diverse land use in the basin, water quality characteristics vary dramatically throughout the basin. In the upper North Platte River basin, water quality is considered high though channel instability issues from historic tie drives, timber harvest, water diversion and trans-basin additions, and dense road networks have contributed sediments and are being monitored in places like Douglas Creek and the Big Creek drainage (Wyoming Department of Environmental Quality 2010). Recent extensive beetle-killed lodgepole pine in the Medicine Bow National Forest is likely to change the timing, frequency, and magnitude of runoff events and the pattern of sediment and wood delivery to stream channels throughout the upper basin. Sage Creek, a tributary to the North Platte downstream of Saratoga, was on the 303(d) List for sediment impairment until 2008 when a series of grazing, riparian restoration, and protection projects implemented earlier reduced this sediment issue. Waters currently considered impaired and on the 303(d) List include: Crooks Creek (oil), tributary to the Sweetwater River; the North Platte River and lower Poison Spider Creek and seven additional small streams and water bodies around Casper (selenium); Wheatland Creek, tributary to the Laramie River downstream of Wheatland (pH and ammonia); Rock Creek, tributary to Wheatland Creek (fecal coliform); Crow Creek near and through Cheyenne (sediment, selenium); and, stream segments in the upper Crow Creek watershed (fecal coliform) (Wyoming Department of Environmental Quality 2010).

Aquatic Wildlife

Fish

Early fur trappers, traders, and settlers frequently traveled along the lower North Platte River on historic trails in the 19th century. Some of the first trading posts in the Wyoming region were established near the river at Fort Laramie and Fort Casper to supply pioneers. Despite the high number of people who followed this river, historic references to fish and fishing are extremely rare, particularly from the North Platte River headwaters. Catfish (probably channel catfish *Ictalurus punctatus*) were known from the Laramie River at Fort Laramie in 1850 and "white fish" (most likely goldeye *Hiodon alosoides*) were reported from the North Platte River west of Casper in 1849. A few historic references to "mountain trout" and "speckled mountain trout" in Deer Creek from the mid-1800s are confounding, since it is widely accepted that trout are not native to the North Platte River basin (Dorn 1986).

The first useful reports of fishes in the basin were conducted by naturalists connected with the Pacific Railroad Survey parties that surveyed sites in the Sweetwater River (Girard 1856 and Girard 1858 *in* Everman and Cox 1896). In 1892 and 1893, an extensive fish survey was conducted on streams and rivers throughout the Missouri basin in Iowa, Nebraska, South Dakota, and Wyoming to identify sites with the best potential for establishing fish hatcheries. Sites sampled in Wyoming included the North Platte River at Casper, Glenrock, and Douglas and in Deer and Little Deer creeks (near Glenrock) and Garden Creek in Casper (Everman and Cox 1896).

Since those initial surveys, aquatic habitats in the North Platte River basin have been significantly impacted by agriculture and demands for irrigation water. Early farmers built diversions and dug canals to farm the arid region. These habitat alterations were evident by the time of the Everman and Cox (1896) surveys. They reported that most of the flow of Deer Creek was diverted during the irrigation season and that Garden Creek flowed only during high runoff and was dry for the remainder of the year due to irrigation.

Recognizing the importance of irrigation water to Wyoming residents, Wyoming Senator F. E. Warren helped with the passage of the National Reclamation Bill and the establishment of the Reclamation Service. Pathfinder Dam, one of the first projects developed by the Reclamation Service as part of the North Platte Project, was completed on the river in 1911 about 45 miles southwest of Casper. By the mid-1920s, over

two thousand miles of canals and laterals had been constructed to provide irrigation water, along with a second reservoir at Guernsey, Wyoming.

Fish surveys were conducted at 2 sites in the South Platte drainage (Lodgepole and Crow creeks) and 26 sites in the North Platte drainage between 1933 and 1946 (Simon 1951). Much of this sampling was conducted during an era of dam construction on the North Platte River. Seminoe Dam was constructed from 1936–1939, and construction of Alcova Dam was started in 1935 and completed in 1938. The mainstem North Platte River in Wyoming was fragmented by four major dams and river habitat had been significantly altered by the time Simon's surveys were conducted. Other significant changes had also occurred by this time. Tie drives had long since altered stream channels in Medicine Bow and Sierra Madre mountain ranges. Roads and highways had been constructed through gullies and canyons, oftentimes significantly altering adjacent stream channels. In addition to the habitat changes, fish were now being stocked and transplanted. By 1881, all accessible stream and lakes in Albany, Carbon, and Laramie counties were stocked with rainbow and brook trout. In 1883, the first carp were introduced when 7,000 carp were brought to the state, and in 1890, the first fish hatchery in the state, at Soldier Springs near Laramie, began stocking brown trout.

Streams and rivers were also heavily impacted by pollution prior to the passage of the Clean Water Act in 1972. Effluent from the tie plant had polluted the Laramie River at Laramie. The mainstem North Platte River was also impacted by pollution prior to passage of the Clean Water Act. Much of the pollution came from effluent from petroleum manufacturing in the Casper area. Wenzel and Leik (1956) conducted water chemistry, invertebrate, and fish sampling at sites from Casper to Guernsey prior to completion of the last large mainstem reservoir, Glendo Reservoir, in 1958. They found at least 120 ppb of phenolic compounds at all sites sampled. The State Health Department of Wyoming tolerated only 1 ppb at that time. Effluent from a sugar refinery at Torrington was found to be a significant source of pollution in the lower North Platte River in the 1950s (Bosley et al. 1963).

The historic fish community in the Platte River basin is the most diverse in the state and is believed to have included 6 game species and 26 27 nongame species (Table 7). A number of the large, turbid, warmwater river species have been extirpated from the North Platte River due to the fragmentation and alteration of the mainstem North Platte River from construction of large dams and reservoirs. Decades of water pollution and dewatering in the 1900s may also have contributed to the demise of a number of large river species. In addition, the entire mainstem river from Casper to the Glendo dam site was chemically treated in 1957 to "remove as nearly as possible all fish prior to its impoundment at the Glendo dam site" (Peterson 1958). The river from Glenrock to Glendo Reservoir, a distance of approximately 70 miles, was chemically treated a second time in 1966 (Peterson 1966) in an attempt to control the yellow perch population in Glendo Reservoir. The goldeye, sauger, and shovelnose sturgeon were once abundant in the North Platte River, but were rare by 1920 (Simon 1951). The last observation of a (dead) sauger in the river was made following the 1966 treatment (Peterson 1966). Channel catfish were most likely extirpated from the North Platte river by the mid-1950s (Bosley et al. 1963). It is likely that goldeye and shovelnose sturgeon may also have been gone by that time. The sturgeon chub, a species that was probably historically rare in the mainstem North Platte River, was extirpated by 1970 (Baxter and Simon 1970), and the plains minnow, which was nearly gone by 1970, had been extirpated by 1995 (Baxter and Stone 1995).

The mountain sucker has never been documented in the Niobrara or South Platte drainages in the eastern Wyoming. Although

Table 7. Fishes present in the Platte River Basin. * denotes Species of Greatest Conservation Need (SGCN). [E] denotes extirpated from the basin. [?] denotes possibly extirpated from the basin.

Native game	Native nongame	Nonnative game	Nonnative nongame
Black bullhead	Bigmouth shiner*	Bonneville cutthroat	Brook stickleback
Channel catfish	Brassy minnow*	Black crappie	Common carp
Greenback cutthroat trout[E]	Central stoneroller*	Bluegill	Emerald shiner
	Common shiner*	Brook trout	Gizzard shad
Sauger*[E]	Creek chub	Brown trout	Golden shiner
Shovelnose sturgeon*[E]	Fathead minnow	Colorado River cutthroat	Goldfish
Stonecat	Flathead chub*[?]	Freshwater drum	Grass carp
	Goldeye*[E]	Golden trout	Spottail shiner
	Hornyhead chub*	Grayling	
	Iowa darter*	Green sunfish	
	Johnny darter	Kokanee salmon	
	Lake chub	Lake trout	
	Longnose dace	Largemouth bass	
	Longnose sucker	Pumpkinseed	
	Mountain sucker	Rainbow trout	
	Orangethroat darter*	Smallmouth bass	
	Plains killifish*	Snake River cutthroat	
	Plains minnow*[E]	Splake	
	Plains topminnow*	Tiger trout	
	Quillback	Walleye	
	Red shiner	White crappie	
	River carpsucker	Yellow perch	
	Sand shiner	Yellowstone cutthroat	
	Shorthead redhorse		
	Sturgeon chub*[E]		
	Suckermouth minnow*		
	White sucker		

the species is referenced as native in Table 7, historic reports in the North Platte River basin are questionable. The first reference, by the famous ichthyologist Samuel Garman, references mountain sucker from "Indian Creek, Northeast Wyoming Territory before 1880" (Smith 1966). Smith attributed this observation to Indian Creek, a small North Platte River tributary on the north slope of the Laramie Mountain Range that enters the North Platte near Orin, Wyoming. However, the mountain sucker was never documented in any of the other Laramie range streams in the region. This specimen may have been collected from Indian Creek in the Hat Creek (Cheyenne River) drainage. A branch of the Cheyenne-Deadwood stage route followed the Indian Creek road in northeast Wyoming, and Garman may well have traveled this route prior to 1880. This location better fits the "Northeast Wyoming" description and the species was recently collected in the headwaters of this drainage (Barrineau et al. 2007).

Simon reportedly collected mountain sucker from Picket Lake in the Sweetwater basin in 1938 and reported that the species was common "in the upper Sweetwater River" (Simon 1951). Hubbs et al. (1943) reported mountain sucker–

longnose sucker hybrids in the Sweetwater River. Baxter and Stone (1995) presumed that the mountain sucker had been extirpated from the North Platte River drainage; however, mountain sucker were observed in Rock and Long creeks in the Sweetwater River drainage during surveys in 1999 and 2000, respectively (Kevin Johnson, personal communication). WGFD biologists recently reported observing mountain sucker spawning in Bolton Creek, a tributary to the mainstem North Platte River upstream of Casper, but identification was not verified (Matt Hahn, personal communication). If native to the North Platte River basin, the historic range may have been restricted to mid-elevation tributaries upstream from Casper and downstream of the Seminoe Mountains.

Trout are not native to the North Platte or Niobrara river drainages in Wyoming. A few historic journal references to "speckled mountain trout" and "mountain trout" in Deer Creek, a tributary to the North Platte River near Glenrock, in the mid-1800s (Dorn 1986) are generally discounted due to the complete lack of any other reports of cutthroat trout anywhere in the North Platte River basin. However, the historic range of the greenback cutthroat trout is reported to have included the headwaters of the South Platte River basin in Wyoming, including Dale and Lonetree creeks. The greenback cutthroat trout is listed as a threatened species under the endangered species act, but it is likely that this subspecies has been extirpated from Wyoming for nearly 100 years.

Fish management efforts in the basin throughout the mid to late 1900s primarily focused on game species and management of mainstem reservoir fisheries. However, a number of reports include references to native species occurrences in the mid 1900s (Peterson and Leik 1956, Wenzel and Leik 1956, Peterson 1958, Hudelson 1966).

In the early 1990s, the Wyoming Game and Fish Department funded a PhD project at the University of Wyoming, to survey warmwater stream fishes of the Missouri River drainage in Wyoming. This was the most detailed survey of Wyoming fishes that had been conducted prior to the 2005 Comprehensive Wildlife Conservation Strategy. Surveys conducted between 1992 and 1995 included 68 sites in the North Platte drainage and 8 sites in the South Platte drainage (Patton 1997). Patton compared survey results to those from the 1960s and described trends in species occurrences across several spatial scales, including sites, streams, subdrainages, and drainages (Patton et al. 1995, Patton et al. 1998, Patton 2001). He found that populations of many native species in the Missouri River drainage had been reduced since the 1960s, and that the flathead chub, another large, turbid, river species that spawns in warm water, may have been extirpated from the Platte River basin. The flathead chub was not reported during extensive native fish surveys in the basin by Patton (1997), Bear and Barrineau (2007) or Moan et al. (2010), but biologists documented flathead chub at two sites on the mainstem North Platte River in 1996 (WGFD 1996) and at a mainstem site near the confluence of the Laramie River in 1997 (WGFD 1997). The current status of the species is not known.

Populations of three species that tend to prefer small, clear, tributary streams—the suckermouth minnow, hornyhead chub, and bigmouth shiner—have been greatly reduced, but continue to persist in very small portions of the basin. However, hornyhead chub are found only in the North Laramie River and lower Laramie River in Wyoming. The species may be extinct in Montana, Colorado, North Dakota, South Dakota, Nebraska, and Kansas.

Although salmonids are not historically native to the North Platte River basin, conditions in the mainstem river upstream of Saratoga, in reservoirs and tailwaters, and in tributaries of the Medicine Bow, Sierra Madre, and Laramie mountain ranges proved to be particularly well suited for trout. Rainbow, brook, brown, and cutthroat trout have been widely stocked throughout the basin, providing popular and productive sport fisheries. Trout fisheries on the mainstem North Platte River above Saratoga and below Gray Reef Reservoir provide some of the most prized large river trout fisheries in the

state. Brook trout, cutthroat trout, golden trout, grayling, and splake are stocked to provide popular fisheries in mountain lakes that historically supported no game fish.

Numerous warmwater game species have also been stocked in the basin to provide important sport fisheries. Walleye provide popular sport fisheries in most of the mainstem North Platte River reservoirs.

Aquatic Reptiles

Four turtles are likely to be found in the North Platte River basin, all of which are considered native species. The western painted turtle, western spiny softshell, and ornate box turtle are SGCN, and the eastern snapping turtle is not. It is assumed that the western painted turtle is the only species of the four that might also be found in the South Platte River basin. Only the western spiny softshell has been documented in the basin west of the Laramie Mountains. The distribution of this species may extend up the North Platte River as far as Seminoe Reservoir.

All four species are suspected to reside in subdrainages throughout the eastern portions of the North Platte River basin, but actual observations are very limited. There are no documented occurrences of the ornate box turtle in the state, but the range of the species may include the North Platte River basin near the Nebraska state line.

Baseline survey data are needed for all turtles in the Platte River basin.

Freshwater Mollusks and Crayfishes

Wyoming is still in the discovery phase in terms of its freshwater bivalve mollusks and gastropods. Although fingernail and pill clams and aquatic gastropods are often encountered during invertebrate sampling, few published accounts of mollusk collections exist (Beetle 1989, Henderson 1924, Hoke 1979, Hovingh 2004). Native mussels, clams,, and gastropods are present in every major Wyoming drainage, except the Green River and Great Divide basins where no bivalve mussels (Order Schizodonta) have been documented. All native mussels, clams, and gastropods are considered SGCN by the WGFD due to a lack of information regarding status.

As of early 2010, seven species of native mussels are known to inhabit Wyoming waters. Three species are known from the Platte River basin, including the cylindrical papershell *Anodontoides ferussacianus*, plain pocketbook *Lampsilis cardium*, and fatmucket *Lampsilis siliquoidea*. Twenty occurrences of the cylindrical papershell are known from the Platte River basin, seven of which were live. This species has been documented in tributaries of the North and South Platte Rivers in Wyoming, including the lower Laramie River and Horse, Crow, and Lodgepole creeks. There have been 18 documented occurrences of the plain pocketbook in the basin, but only one live specimen has been collected since 1917, in the lower Laramie River. Empty shells are common to abundant at locations on the North Platte River mainstem below Grey Reef dam and in the lower Laramie River. Recent credible reports and the collection of shells that appeared to be alive indicate that living populations are likely present at other locations in the drainage. Empty fatmucket shells were collected at three locations on the North Platte River, Laramie River, and Deer Creek, a North Platte tributary. No live fatmucket occurrences are documented in this drainage.

One biologist position on the Wyoming Game and Fish Department Aquatic Assessment Crew has been assigned to coordinate mollusk sampling and collect observations. Field personnel have been trained to record bivalve mollusk observations during other routine fieldwork and submit specimens. A voucher specimen collection was established at the University of Colorado Natural History Museum in Boulder, Colorado, in 2007.

In 2009, the WGFD funded a project at the University of Wyoming to conduct a literature review, identifying the current and historical information on freshwater gastropod distributions in Wyoming and to develop gastropod collection methods for WGFD, and assess the distribution of freshwater gastropods

in the Bighorn and North Platte River drainages in Wyoming. Researchers attempted to sample four sites in every 8-digit HUC basin. Data suggest that sampling techniques often employed for macroinvertebrates do not accurately reflect the occurrence of snails. Sampling protocols for freshwater gastropods will also be developed as part of this research project.

Researchers surveyed sites throughout the Platte River basin and classified six types of mesohabitats. *Run*, *riffle*, *pool*, and *backwater* were used to describe discrete habitats in streams and rivers. *Mainstem* was used to indicate sites where the margin of the mainstem North Platte River was sampled. Finally, *littoral* was used to describe habitat in the littoral zone of standing waters. Distributions of gastropods and habitat associations will be provided in the M.S. thesis (Charlotte Narr) for this project in winter 2010–2011, and current distributions will be compared to those derived from observations reported by Beetle (1989).

Little information is available on the distribution of Wyoming crayfishes. All native crayfishes are considered SGCN, except *Orconectes virilis* which is classified as NSS4. Between 1985 and 1987 a survey of crayfishes was conducted in the state (Hubert 1988). These surveys were repeated between 2007 and 2009 (Hubert 2010). Four species, all of which are native, were found in the Platte River basin: *Orconectes immunis, O. virilis, O. neglectus neglectus*, and *Cambarus diogenes diogenes*. A single species, *O. neglectus neglectus*, was found in the South Platte River basin (Crystal Reservoir) during both the surveys. *C. diogenes* was found only in Horse Creek in the North Platte River basin and only in the 1985–1987 survey. *O. immunis* was the most widespread species in the Platte River basin during both surveys, but appears to have been displaced by *O. virilis* at a number of locations. More detailed surveys are needed to describe the distribution and status of crayfishes in Wyoming.

Table 8. Species of Greatest Conservation Need present in the Platte River Basin

Fish

Bigmouth shiner
Brassy minnow
Central stoneroller
Common shiner
Hornyhead chub
Iowa darter
Orangethroat darter
Plains killifish
Plains topminnow
Suckermouth minnow

Reptiles

Ornate box turtle
Western painted turtle
Western spiny softshell

Crustaceans

Calico crayfish
Devil crayfish
Ringed crayfish

Mollusks

Cylindrical papershell mussel
Fatmucket mussel
Plain pocketbook mussel

Identification of Conservation Areas

Warmwater stream assessments (Quist et al. 2004) were conducted in the North Platte tributaries, Laramie River, and Horse Creek drainages from May through October 2004 and 2005 to assess the status of fish assemblages and habitat in the North Platte River basin. Sampling was not conducted in the South Platte River basin.

These data were used to prioritize subdrainages based on their conservation value for native species. Bear (2006) used a combination of modified index of centers of density (MICD) scores (Patton 1997) and an index of biotic integrity (IBI) developed in Montana and modified for use in Wyoming to prioritize streams. She identified the lower Laramie River, North Laramie River and North Horse, LaBonte, and Bed Tick creeks as priorities in the North Platte River basin. The lower Laramie River and Horse Creek contained the highest native species diversity with 17 and 16 native species, respectively. Both streams contain multiple fish SGCN. Agricultural water

development and nonnative fishes pose the greatest threats to native species in these watersheds. LaBonte and Bed Tick creeks contained 11 and 7 native species, respectively.

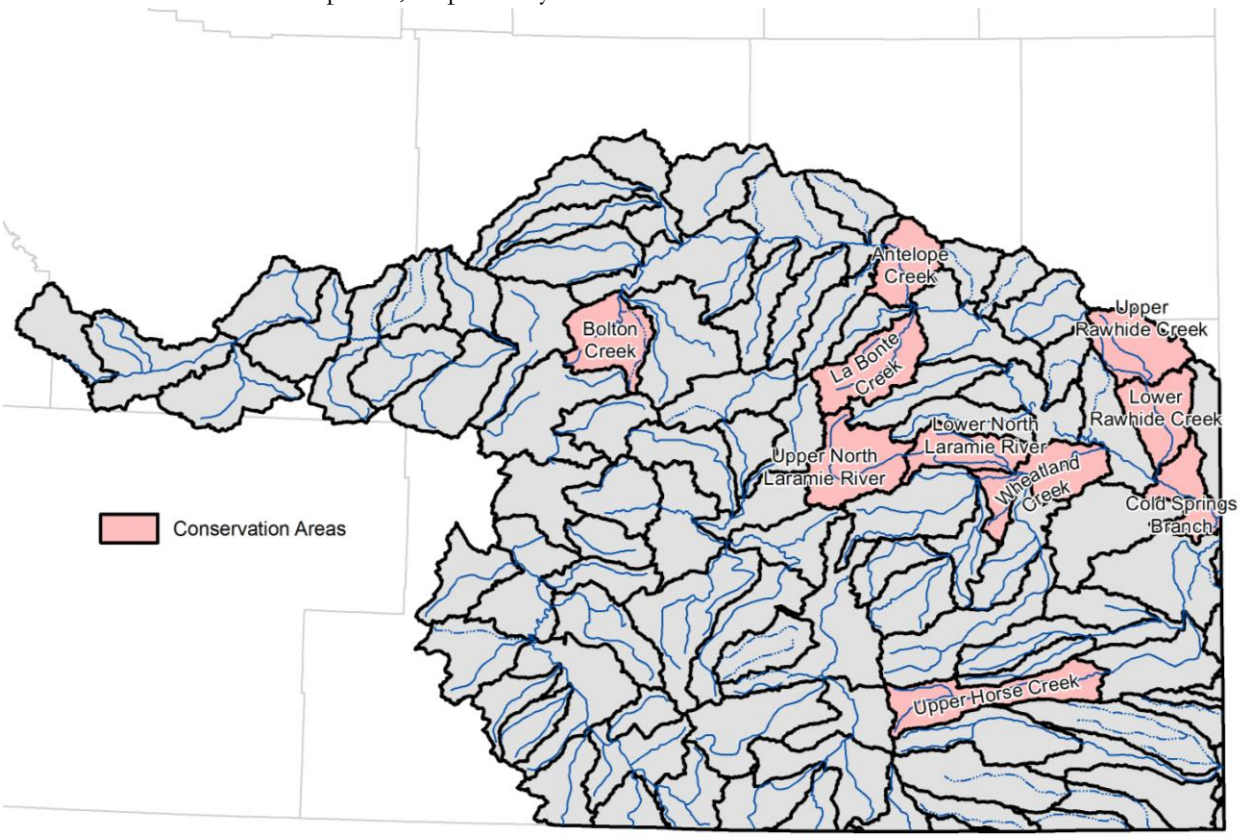

Figure 8. Aquatic Wildlife Conservation Areas in the Platte River Basin.

Aquatic wildlife conservation areas in the Platte River Basin were identified (Figure 8). When the 2004–2005 data were considered on the basis of native species diversity and presence of fish SGCN rather than MICD and IBI scores, 6 priority conservation areas were identified in the Casper Region. The highest priority streams in the Casper region for the conservation of native species are clearly LaBonte and LaPrele creeks. LaBonte Creek included 11 native species, 3 of which are SGCN and LaPrele Creek has 9 native species, 2 of which are SGCN. Four other streams, Deer, Rawhide, Bed Tick, and Shawnee creeks should also be considered for the conservation of native species. Although the upper, mountain portions of these drainages contain few native species, the lower reaches between the Laramie Mountains and the North Platte River contain 6-8 native species per stream and 2-3 SGCN per stream. Shawnee and Bed Tick creeks are very small streams that are not managed for sport fish. LaBonte, LaPrele, and Deer creeks are three of the largest North Platte River tributaries draining the northeast slope of the Laramie Mountains. All three streams are also managed to provide trout fisheries.

Conservation areas in the North Laramie and lower Laramie rivers will be refined upon completion of the ongoing prairie stream conservation project in southeast Wyoming (see Conservation Initiatives below).

State Wildlife Grant (SWG) funds were used to conduct additional surveys at 18 sites in the lower Laramie River, 4 sites in the North Laramie River, 15 sites in the Horse Creek drainage, and 7 sites in the Lodgepole Creek drainage in 2008 and 2009.

Priority drainages and habitats have not yet been defined for the conservation of aquatic reptiles, freshwater mollusks, or crayfishes.

Threats

Water development/altered flow regimes – Moderate
Natural flow regimes in stream segments around the state have been altered by human activities including irrigation diversions and water developments for more reliable water supply, hydropower, and flood control. These altered flow regimes are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). Lateral and longitudinal hydrologic connectivity and physical access by fish populations to all habitats necessary to complete their life history is limited throughout the drainage. In-channel obstructions and increased dewatering have reduced some populations of native stream fishes.

The need for additional water for human use will intensify in the immediate future, and that trend will be especially evident in the western U.S. This trend has multi-faceted consequences for fish and wildlife and the habitats upon which they depend. In Wyoming, trans-basin water diversions are not uncommon and are likely to be further proposed and pursued. Energy diversification, including hydropower development, may increase as the nation's energy demands rise. Warmer conditions with more erratic precipitation— which some predict for Wyoming's future climate—may heighten the need for additional water development (water storage) for municipal and agricultural purposes.

The likely trend will be water development projects closer to the delivery point and conveyance via pipelines instead of stream channels. Additional emphasis will likely be placed on lining irrigation ditches and other practices to more efficiently use water for consumptive purposes. The net effect of all such water management practices will be to alter the timing, magnitude, and duration of natural hydrographs and reduce intra- and inter-annual variability in Wyoming's streams and associated riparian corridors (see Wyoming Leading Wildlife Conservation Challenges – Climate Change, and the Riparian habitat chapter).

While water development can threaten native species, some introduced species, including popular sport fisheries, have thrived in the face of water development. The simplification of natural systems by human development tends to favor species with generalized and broad habitat requirements. For example, the walleye fisheries in the North Platte River reservoirs and Boysen Reservoir depend on the consistent deep water and forage production inherent in these man-made water bodies. Stable stream flow releases from dams, with relatively low peak flows and relatively high base flows, perpetuate productive sport fisheries. The famous "Miracle Mile" trout fishery below Kortes Dam and the "Grey Reef" fishery below Alcova Dam are examples.

Invasive species – High
Aquatic invasive species (AIS) including fish, pathogens, plants, and mollusks are currently present in Wyoming, most notably the New Zealand mudsnail and the parasite that causes whirling disease. These AIS can alter the native species in a watershed through competition, disease, shifts in food availability, and direct mortality. While AIS currently in Wyoming can cause problems and need to be controlled, the most significant known threat to Wyoming's native species is from zebra and quagga mussels, based on their proximity to Wyoming and demonstrated negative impacts in other areas. Zebra and quagga mussels can out-compete

native mussels for space and resources and will attach to and smother native mussels causing mortality (Cummings and Mayer 1992, Strayer 2008). They filter plankton out of the water column at high rates (up to a liter per day per individual) so that little plankton remains available for fish populations, resulting in their decline (Benson 2009). In addition, invasive mussels produce pseudofeces which can lead to harmful algal blooms affecting numerous aquatic species.

The Wyoming Aquatic Invasive Species Act of 2010 allowed the WGFD to implement the Wyoming AIS Program with the goal of executing a coordinated strategy to prevent, control, contain, monitor, and whenever possible, eradicate aquatic invasive species from the waters of the state. The Wyoming AIS Management Plan of 2010 is the framework for this three-part strategy which includes 1) outreach and education, 2) inspection of watercraft to increase boater awareness of AIS threats and prevention and to intercept high risk watercraft that may be transporting AIS, and 3) monitoring of waters to allow for early detection and rapid response to any new AIS populations in the state.**Drought and climate change – Moderate**
Climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and run-off, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the yearly cycle and to lower base flows (Barnett et al. 2004). Drought lowers water tables, leading to reduced plant growth and reproduction. Riparian vegetation declines lead to lower bank stability, higher siltation and altered stream habitat quality and quantity. Lower water levels increase water temperatures and reduce the habitat available to fish and other aquatic wildlife. All these conditions can be detrimental to the health and reproductive success of all aquatic wildlife species.

Conservation Initiatives

The WGFD has pursued multiple projects to conserve SGCN in the Platte River basin since 2005. Multiple sources of funding have been used to fund projects with partners at local universities. Other projects have been conducted by department personnel.

The WGFD conducted a SWG-funded project to assess the distribution and status of fishes in eastern Wyoming, including the Platte River basin, in 2004 and 2005—10 years after Patton's surveys (Patton 1997). One of the project objectives was to utilize the newly developed Warmwater Stream Assessment (WSA) protocol (Quist et al. 2004) to assess habitat conditions and fish communities in the Platte River basin. Surveys were conducted at 15 sites on 10 North Platte River tributaries, 14 sites on 5 streams in the Horse Creek sub-basin, and 18 sites on 8 streams in the Laramie River basin (Bear and Barrineau 2007). Results were used to begin prioritizing areas in the Platte River basin for native species conservation (Bear 2006; see Identification of Conservation Areas above).

A second SWG-funded project was initiated in 2008 to conduct additional detailed habitat and fish community inventories in two priority watersheds in the North Platte River basin, the Laramie River and Horse Creek watersheds. Baseline surveys were also conducted in Lodgepole Creek in the South Platte River basin. The project was conducted by a WGFD contract biologist and technicians in order to 1) refine knowledge of the distribution of fish SGCN within these basins, 2) conduct the first detailed fish and habitat surveys in the South Platte River basin in Wyoming, 3) use the additional data to prioritize watersheds at the HUC 5 level for native fish conservation efforts, and 4) develop Best Management Practices for native fishes in southeastern Wyoming (Moan et al. 2010). A final report will be completed in late 2010. The project results will be used by WGFD biologists to identify management opportunities to benefit native aquatic species on private lands within priority sub-basins.

In 2008, SWG funds were used to conduct a three-year project to better understand the distribution, abundance, habitat use, and ecology of hornyhead chub to further efforts to conserve the species in southeastern Wyoming. The project is being conducted by a Colorado State University (CSU) Master's student, under the supervision of Dr. Kevin Bestgen at the CSU Larval Fish Laboratory. Project objectives are to 1) describe historical and present distribution and abundance of hornyhead chub in Wyoming, with an emphasis on the Lower Laramie River drainage, 2) describe habitat use, including spawning habitat requirements, of hornyhead chub in the Lower Laramie River drainage, 3) identify factors that limit the distribution and abundance of hornyhead chub in Wyoming, and 4) identify specific threats to continued persistence of hornyhead chub in Wyoming and potential management strategies to enhance their conservation status. A thesis will be completed in the spring of 2011.

In 2009, funding provided by the Wyoming Governor's office was used to fund a project through the University of Wyoming, to begin assessing the status of aquatic gastropods in Wyoming. The project was conducted by Charlotte Narr, a University of Wyoming Master's student, under the supervision of Dr. Amy Krist. Project objectives are to conduct a thorough literature review to determine the historical distributions of aquatic gastropods in Wyoming, develop appropriate sampling protocols for freshwater gastropods and their aquatic habitats, and to conduct extensive sampling in the North Platte and Bighorn River drainages. A thesis will be completed during the winter of 2010–2011.

Four turtles are believed to inhabit the Platte River basin, in addition to more than two dozen other reptile and amphibian SGCN, but little is known about the status of these species. The WGFD will initiate a SWG-funded project in 2011 to determine reptile and amphibian distributions, relative abundances, and habitat associations within priority watersheds in the Platte River. Information from this project will begin to provide biologists with the necessary data to better manage amphibians and reptiles in southeastern Wyoming. The project will be completed by a WGFD contract biologist and technicians under the supervision of the WGFD herpetologist.

The department's Fish Division has developed basin management plans to guide management across the state. These plans provide background and history of aquatic wildlife management as well as management direction for sportfish, SGCN, and aquatic habitat. The management direction includes reference to the SWAP and the Strategic Habitat Plan, attempting to incorporate management direction from those two plans that is relevant to each basin into each basin management plan.

The WGFD has the opportunity to comment on most environmentally sensitive construction or management actions submitted through the National Environmental Policy (NEPA) review process. Projects include state and federal lands and private ventures that require action by state or federal agencies. The WGFD regularly provides recommendations to protect habitat and populations of aquatic wildlife at the project level. Department efforts are guided by the Wyoming Game and Fish Commission mitigation policy (WGFC 2008).

The WGFD has a rigorous collection permitting system that restricts commercial, scientific, and educational activities (WGFC 2005a). It provides protection to aquatic wildlife. The regional fisheries supervisor reviews all requests for permits and recommends either approval or rejection of the request based on merit and impacts to the resource in question.

The movement of fish by WGFD employees is critical to address many of the aspects, thus the intent, of our mission. However, the act of moving or importing fish also presents risks that could potentially jeopardize the mission. To address this conflict, a method to determine the relative level of risk associated with any proposed fish importation and/or transplant was developed. The WGFD utilizes Hazard Analysis and Critical Control Point (HACCP) procedures (Gunderson and Kinnunen 2001)

and has developed a risk assessment matrix from these procedures to manage transplants, thereby protecting the aquatic resources within the state. Using the procedures and matrix, WGFD fisheries managers develop documentation that explains whether a proposed transplant is nearly free of risk. The documentation must address all aspects of the transplant including, but not limited to, verifying that the fish being transplanted are disease free, the water source is disease free, and non-target species are excluded from transplant. Source populations of salmonids are verified disease free by collecting a standardized number of fish, having them inspected by an American Fisheries Society-certified Fish Health Inspector for all known pathogens, and receiving disease free certification. The resulting documentation is reviewed and either approved or denied by the WGFD Chief of Fisheries. No whirling disease-infected trout, native or nonnative, are stocked by the WGFD, and they are not allowed to be stocked by others (WGFC 2003).

In Wyoming, Game and Fish Commission policy precludes the stocking of fish into waters that are capable of satisfactory, self-sustaining fisheries (WGFC 1998). A commonsense, biologically-based protocol for fish rearing and stocking has historically been followed in Wyoming, with emphasis on management for native fish and wild fish wherever possible (Wiley 1995). Only 3% of the streams listed in the Wyoming Game and Fish Department database inventory are stocked annually. Maintenance of native cutthroat trout subspecies has been a management priority for more than 40 years (Stone 1995) and protection from stocked predators of native nongame fishes has been an important consideration for at least the last decade.

Wyoming has regulations prohibiting unauthorized stocking of fish or fish eggs. Private citizens can only stock waters in Wyoming following a WGFD permitting system that includes review by the responsible regional fisheries supervisor (WGFC 2005b). WGFD has increased education efforts regarding the problems associated with illegal introductions of fish. The Wyoming Legislature increased the penalties for illegal fish stocking in 2010 and the Wyoming Wildlife Protectors Association has offered $2,500 rewards for information leading to the conviction of individuals found illegally moving or stocking fish.

Habitat management efforts are guided by the Strategic Habitat Plan (SHP) that was adopted by the Wyoming Game and Fish Commission in January 2009 (WGFC 2009). The SHP includes five goals: 1) Conserve and manage wildlife habitats that are crucial for maintaining terrestrial and aquatic wildlife populations for the present and future, 2) Enhance, improve, and manage priority wildlife habitats that have been degraded, 3) Increase wildlife-based recreation through habitat enhancements that maintain or increase productivity of wildlife, 4) Increase public awareness of wildlife habitat issues and the critical connection between healthy habitat and abundant wildlife populations, and 5) Promote collaborative habitat management efforts with the general public, conservation partners, private landowners, and land management agencies. Efforts are focused in priority areas in each of the management regions and include crucial areas essential for conservation of important species and communities and enhancement areas, which represent places where work should be conducted to manage or improve wildlife habitat.

The Wyoming Legislature created the Wyoming Wildlife and Natural Resource Trust (WWNRT) in 2005. Funded by donations, legislative appropriation, and interest earned on a permanent account, the purpose of the program is to enhance and conserve wildlife habitat and natural resource values throughout the state. Any project designed to improve wildlife habitat or natural resource values is eligible for funding. The WWNRT is an independent state agency governed by a nine-member citizen board appointed by the Governor. The WGFD has partnered with the WWNRT to successfully implement a wide range of projects to benefit a broad array of Wyoming's wildlife.

Landscape Conservation Cooperatives (LCCs) are a new program of the U.S. Fish and Wildlife Service. The vision is that they serve as applied conservation science partnerships focused on a defined geographic area that inform on-the-ground strategic conservation efforts at landscape scales. LCC partners include U.S. Department of Interior agencies, other federal agencies, states, tribes, non-governmental organizations, universities, and other stakeholders. It is hoped that LCCs will enable resource management agencies and organizations to collaborate in an integrated fashion within and across landscapes. LCCs are intended to provide scientific and technical support to inform landscape-scale conservation using adaptive management principles. They are proposed to engage in biological planning, conservation design, inventory and monitoring program design, and other types of conservation-based scientific research, planning, and coordination. It is hoped that LCCs will play an important role in helping partners establish common goals and priorities, so they can be more efficient and effective in targeting the right science in the right places. Products developed by LCCs should inform the actions of partners and other interested parties in their delivery of on-the-ground conservation. The WGFD will continue to participate in the LCC process as appropriate.

The National Fish Habitat Action Plan (NFHAP) was developed by a coalition of fisheries professionals, state and federal agencies, tribes, foundations, conservation and angling groups, businesses and industries, all determined to reverse the declines of America's fish habitats. In its design, the plan encompasses five important lessons that emerge from America's past efforts to protect and restore fish habitat: 1) Be strategic rather than merely opportunistic, 2) Address the causes of and processes behind fish habitat decline, rather than the symptoms, 3) Provide increased and sustained investment to allow for long-term success, 4) Monitor and be accountable for scientifically sound and measurable results, and 5) Share information and knowledge at all levels from local communities to Congress. The Wyoming Game and Fish Department has been heavily involved with the development and implementation of the NFHAP. WGFD is involved with three NFHAP partnerships, Great Plains Fish Habitat Partnership, the Western Native Trout Initiative, and the Desert Fishes Habitat Partnership. The Great Plains Fish Habitat Partnership covers the Platte River basin.

The Great Plains Fish Habitat Partnership is a coalition of interests concerned for the future of the rivers and streams of the Great Plains of the north central United States and the species that rely on these unique habitats. The Partnership is comprised of individuals, groups, and organizations that recognize the values of these aquatic habitats to fish and aquatic species, communities, and people that call this area home. The goal of the partnership is to work together to conserve (protect, restore, and enhance) aquatic resources of rivers and streams throughout the prairies of the central United States. This partnership will focus on the conservation of remaining high quality prairie rivers and streams, the restoration of highly degraded habitats, where feasible, and the enhancement of habitats that have been moderately impaired. Wyoming is an active participant in the Great Plains Fish Habitat Partnership.

Recommended Conservation Actions

Secure and enhance populations and habitats in SGCN priority areas.
Evaluate the threats that nonnative species pose to native fishes in priority conservation areas in the basin. Where necessary and feasible, reduce or eliminate populations of nonnative fishes from priority conservation areas in the basin.

Work with private landowners to implement conservation actions to benefit SGCN in priority drainages in the Platte River basin. Activities may include implementing best management practices, installation of riparian fencing, construction of instream structures, bank stabilization, enhancing riparian

vegetation, controlling exotic riparian and aquatic species, installing fish passage and screening structures, and acquiring conservation easements and/or instream flows.

Investigate the feasibility of reintroducing sauger to the North Platte River above Glendo Reservoir.

Fill remaining data gaps for SGCN distribution.
Determine if mountain sucker are present in Bolton Creek.

Determine if flathead chub persist in the mainstem North Platte River.

Determine the status, distribution, and habitat associations of turtles, mollusks, and crayfishes in the Platte River basin.

Identify swimming and passage abilities of prairie SGCN fish species (burst speeds, jumping ability, etc.,).

Describe the distribution and intactness of aquatic habitats.
Describe temporal and spatial patterns of stream flow and diversions in SGCN priority areas. Developing a better understanding of water availability patterns and constraints may highlight opportunities for focused conservation action.

Protect relatively intact riparian systems and restore those in proximity to SGCN priority areas.
Remove invasive and noxious vegetation from riparian areas in the lower Cheyenne River and Lance Creek watersheds (McGree et al. 2010).

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN.
The importance and role of aquatic SGCN is poorly understood by the general public. Efforts should be enhanced to increase public education in this area.

Continue aquatic habitat work in the basin.
Supply flow or other information to the State Engineer's Office and Water Development Office to facilitate adjudication of instream flow water rights.

Monitor instream flow segments for compliance with approved instream flow levels. Pursue compliance as needed when water is available and in priority.

Explore water management approaches that enhance fish habitat.
Identify opportunities to work with private water right holders to manage water diversions and uses with the goal of restoring natural flow regimes. Where opportunities exist, develop cooperative strategies with landowners and other partners to implement strategies that are beneficial to aquatic resources.

Identify stream segments where habitat and available flow regimes indicate a need to file instream flow water rights for SGCN. As opportunities are identified, conduct needed studies and file for state-held instream flow water rights.

Identify fish and wildlife mitigation for new reservoirs as they are proposed including instream flow regimes and minimum fishery pools. Ensure that mitigation recommendations are included as conditions in applicable permits.

Continue building voucher collections for all aquatic wildlife.
Continue to fill voids in voucher inventory for fish per WGFD protocol (Zafft and Bear 2009).

Mussel specimens have been donated to the University of Colorado Museum, and new specimens will be added as needed. A database containing freshwater mussel occurrences will be maintained and enhanced with specimen photos.

Determine if there is interest in voucher specimens of gastropods. If so, expand the voucher program to include those organisms.

Complete the comprehensive survey for freshwater mussels.
Future efforts will focus on filling gaps in distribution information, initiating comprehensive drainage surveys, maintaining

WGFD records, and expanding specimen collections.

Follow up on recommendations from graduate research projects.
The WGFD-funded graduate project at the University of Wyoming will provide direction for gastropod sampling methods. Those recommendations should be followed, and baseline gastropods surveys should be conducted in the Platte River basin.

A WGFD-funded graduate project at the Colorado State University will provide insights into hornyhead chub population dynamics and limiting factors. Management recommendations should be considered.

Increase connectivity where appropriate.
Document locations and measure physical variables at passage barriers and diversions within SGCN priority areas. Populate the existing WGFD database with this information and identify priorities for passage or screening solutions.

Remove barriers or develop passage solutions to provide connectivity within SGCN priority areas.

Monitoring

Establish standardized monitoring protocols and locations for native SGCN.
Monitor water quantity and temperature in areas containing important native SGCN populations.

Monitor the establishment and spread of invasive species.

Establish and implement monitoring plans for SGCN in all priority conservation areas.

Literature Cited

ABELL, R. AND 27 OTHER AUTHORS. 2008. Freshwater ecoregions of the world: a new map of biogeographic units for freshwater biodiversity conservation. BioScience 58(5):403–414.

BAILEY, R. G. 1995. Descriptions of the ecoregions of the United States. US Forest Service. Miscellaneous Publication No. 1391.

BARNETT, T., R. MALONE, W. PENNELL, D. STAMMER, B. SEMTNER AND W. WASHINGTON. 2004. The effects of climate change on water resources in the West: introduction and Overview. Climatic Change 62: 1–11.

BARRINEAU, C., B. BEAR, AND L. TOOKER. 2007. Status of habitat and native species in Northeast Wyoming prairie streams. Wyoming Game and Fish Department, Cheyenne, WY.

BARTOS, T. T., L. L. HALLBERG, J. P. MASON, J. R. NORRIS, AND K. A. MILLER. 2006. Water resources of Carbon County, Wyoming. U.S. Geological Survey Scientific Investigations Report 2006–5027.

BAXTER, G. T. AND M. D. STONE. 1995. Wyoming Fishes. Wyoming Game and Fish Department Bulletin Number 4. Cheyenne, WY.

BAXTER, G. T., AND J. R. SIMON. 1970. Wyoming Fishes. Wyoming Game and Fish Department Bulletin Number 4. Cheyenne, WY.

BEAR, B. 2006. Prioritization of eastern Wyoming prairie streams for conservation. Wyoming Game and Fish Department, Cheyenne, WY.BEAR, B. AND C. BARRINEAU. 2007. Status of habitat and native species in southeast Wyoming prairie streams. Wyoming Game and Fish Department, Cheyenne, WY.

BEETLE, D. E. 1989. Checklist of recent Mollusca of Wyoming. Great Basin Naturalist 49(4): 637-645.

BENSON, A. J. 2009. Zebra mussel sightings distribution. Retrieved April 17, 2009 from http://nas.er.usgs.gov/taxgroup/mollusks/zebra mussel/zebramusseldistribution.asp.

BOSLEY, C. E., R. L. MILLIS, L. PETERSON, AND R. HUDELSON. 1963. To determine if materials known to be toxic to fish exist in waste waters being contributed to the North Platte River by the Holly sugar refinery at Torrington, Wyoming. Wyoming Game and Fish Department Administrative Report, Cheyenne, WY.

BUREAU OF LAND MANAGEMENT. 2007. Record of decision and approved Casper Resource Management Plan. Casper Field Office. December 2007. Accessed August 3, 2010, at http://www.blm.gov/pgdata/etc/medialib/blm/ww/programs/planning/rmps/casper/rod.Par.5152.File.dat/01_rod_armp.pdf.

BUREAU OF LAND MANAGEMENT. 2008. Record of Decision and approved Rawlins Resource

Management Plan. Rawlins Field Office. December 2008. Accessed July 22, 2010, at http://www.blm.gov/wy/st/en/programs/Planning/rmps/rawlins/rod_armp.html.

CHAPMAN, S. S., S. A. BRYCE, J. M. OMERNIK, D. G. DESPAIN, J. ZUMBERGE, AND M. CONRAD. 2004. Ecoregions of Wyoming (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000).

COMER, P., D. FABER-LANGENDOEN, R. EVANS, S. GALWER, C. JOSSE, G. KITTEL, S. MENARD, M. PYNE, M. REID, K. SCHULZ, K. SNOW, AND J. TEAGUE. 2003. Ecological systems of the United States: a working classification of U.S. terrestrial systems. NatureServe, Arlington, VA.

CUMMINGS, K. S., AND C. A. MAYER. 1992. Field guide to freshwater mussels of the Midwest. Illinois Natural History Survey Manual 5.

CURTIS, J. AND K. GRIMES. 2004. Wyoming Climate Atlas. http://www.wrds.uwyo.edu/sco/climateatlas/toc.html.

DORN, R. D. 1986. The Wyoming landscape, 1805–1878. Mountain West Publishing, Cheyenne, WY.

EVERMAN, B. W. AND U. O. COX. 1896. A report upon the fishes of the Missouri River basin. Report of the U.S. Commissioner of Fish and Fisheries for 1894:325–429. Government Printing Office, Washington, D.C.

GUNDERSON, J.L., AND R.E. KINNUNEN. Editors. 2001. Sea Grant Aquatic Nuisance Species. Hazard Analysis and Critical Control Point Training Curriculum Minnesota Sea Grant Publication Number: MNSG-F11, Minnesota Sea Grant, 2305 E 5th Street, Duluth, Minnesota.

HENDERSON, J. 1924. Mollusca of Colorado, Utah, Montana, Idaho and Wyoming. University of Colorado Studies 13:65–223.

HIGGINS, J. V., M. T. BRYER, M. L. KHOURY, AND T. W. FITZHUGH. 2005. A freshwater classification approach for biodiversity conservation planning. Conservation Biology 19:432–445.

HOKE, E. 1979. Wyoming mussel distributions as revealed by survey activities conducted during the summer of 1978. Wyoming Game and Fish Department, Cheyenne, WY.

HOVINGH, P. 2004. Intermountain freshwater mollusks, USA (Margaritifera, Anodonta, Gonidea, Valvata, Ferrissia): geography, conservation, and fish management implications. Monographs of the Western North American Naturalist 2:109–135.

HUBBS, C. L., L. C. HUBBS, AND R. E. JOHNSON. 1943. Hybridization in nature between species of catostomid fishes. Contrib. Lab. Vert. Biol., 22:1–76.

HUBERT, W. A. 1988. Survey of Wyoming crayfishes. Great Basin Naturalist 48:370–372.

HUBERT, W. A. 2010. Survey of Wyoming crayfishes: 2007–2009. US Geological Survey Report to the Wyoming Game and Fish Department, Cheyenne, WY.

HUDELSON, R. 1966. A comprehensive investigation of the trout fishery in Glendo Reservoir from January through October, 1964. Wyoming Game and Fish Department, Cheyenne, WY.

LAGESON, D. R. AND D. R. SPEARING. 1988. Roadside geology of Wyoming. Missoula, MT, Mountain Press Publishing Company.

MCGREE, M.M., C.A. MOAN, A. LICKTEIG, AND G.P. EDWARDS. 2010. Draft. Prairie stream fish communities and habitat associations in the Belle Fourche, Cheyenne, Little Missouri, and Little Powder river drainages of Wyoming. Wyoming Game and Fish Department, Cheyenne, WY.

MILLER, K. A. 2003. Peak-flow characteristics of Wyoming streams. U.S. Department of Interior, U.S. Geological Survey. Water-Resources Investigation Report 03–4107.

MOAN, C. A., M. M. MCGREE, AND G. P. EDWARDS. 2010. Draft. Prairie stream fish communities and habitat associations in the Niobrara River, Lower Laramie River, Horse Creek and Lodgepole Creek drainages. Wyoming Game and Fish Department, Cheyenne, WY.

NATURAL RESOURCES CONSERVATION SERVICE. 2010. Wyoming Snotel sites. Accessed August 3, 2010 http://www.wcc.nrcs.usda.gov/snotel/Wyoming/wyoming.html.

NATURESERVE. 2009. NatureServe Explorer: Arlington, VA. http://www.natureserve.org/explorer.

NORTHWEST GAP ANALYSIS PROJECT. 2010. http://gap.uidaho.edu/index.php/gap-home/Northwest-GAP. Accessed July 2, 2010.

PATTON, T. M. 1997. Distribution and status of fishes in the Missouri River drainage in Wyoming: implications for identifying conservation areas. Doctoral dissertation. University of Wyoming, Laramie.

PATTON, T. M. 2001. Application of a modified index of centers of density to four drainages within the Missouri River Drainage, Wyoming. Wyoming Game and Fish Department, Cheyenne, WY.

PATTON, T. M., F. J. RAHEL, AND W. A. HUBERT. 1998. Using historical data to assess changes in Wyoming's fish fauna. Conservation Biology 12:1120–1128.

PATTON, T. M., W. A. HUBERT, AND F. J. RAHEL. 1995. Ichthyofauna in streams of the Missouri River drainage, Wyoming. Prairie Naturalist 30: 9–21.

PETERSON, L. 1958. North Platte River fisheries restoration. Federal aid in fish and wildlife restoration job completion report. Project F-18-D-1. Wyoming Game and Fish Department, Cheyenne, WY.

PETERSON, L. 1966. Glendo Reservoir and North Platte rehabilitation. Federal aid in fish and wildlife restoration job completion report. Project F-24-D-4. Wyoming Game and Fish Department, Cheyenne, WY.

PETERSON, L. AND T. H. LEIK. 1956. North Platte River reservoir investigations, 1955. Fisheries Technical Report Number 3. Wyoming Game and fish Department, Cheyenne, WY.

PLATTE RIVER BASIN WATER PLAN. 2006. Final report prepared for the Wyoming Water Development Commission.

QUIST, M. C., W. A. HUBERT, AND F. J. RAHEL. 2004. Warmwater stream assessment manual. Wyoming Game and Fish Department, Cheyenne, WY.

SEAVY, N.E. T. GARDALI, G.H.GOLET, F.T. GRIGGS, C.A. HOWELL, R. KELSEY, S.L. SMALL, J.H.VIERS, AND J.F.WEIGAND. 2009. Why climate change makes riparian restoration more important than ever: recommendations for practice and research. Ecological Restoration 27:330-338.

SIMON, J. R. 1951. Wyoming fishes (revised). Wyoming Game and Fish Department Bulletin Number 4. Cheyenne, WY.

SMITH, G. R. 1966. Distribution and evolution of the North American Catostomid fishes of the subgenus *Pantosteus*, genus *Catostomus*. Misc. Publ. Mus. Zool. University of Michigan, 129:1–132.

STONE, M.D. 1995. Fish stocking programs in Wyoming: a balanced perspective. American Fisheries Society Symposium 15:47-51.

STRAYER, D. L. 2008. Freshwater mussel ecology. University of California Press, Los Angeles.

WENZEL, L. E. AND T. H. LEIK. 1956. A fish management study of Guernsey Reservoir and the adjacent portion of the North Platte River. Fisheries Technical Report Number 5, Wyoming Game and Fish Department, Cheyenne, WY.

WGFD. 1996. Annual fisheries progress report on the 1996 work schedule. Wyoming Game and Fish Department, Cheyenne, WY.

WGFD. 1997. Annual fisheries progress report on the 1997 work schedule. Wyoming Game and Fish Department, Cheyenne, WY.

WILEY, R.W. 1995. A common sense protocol for the use of hatchery-reared trout. American Fisheries Society Symposium 15:465-471.

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY. 2001. Wyoming surface water classification list—Water Quality Division, Surface Water Standards: Wyoming Department of Environmental Quality, June 21, 2001, accessed July 21, 2010, at http://deq.state.wy.us/wqd/watershed/surfacestandards/Downloads/Standards/2-3648-doc.pdf.

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY. 2010. Wyoming Water Quality Assessment and Impaired Waters List (2010 Integrated 305(b) and 303(d) Report). Wyoming Department of Environmental Quality Document #10-0230.

WYOMING GAME AND FISH COMMISSION. 1998. Fish Stocking Policy. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2003. Chapter 10: Regulation for importation, possession, confinement, transportation, sale and disposition of live wildlife. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2005a. Chapter 33: Issuance of scientific research, educational or special purpose permits. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2005b. Regulation governing private fish stocking. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2008. Mitigation policy. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2009. Strategic Habitat Plan. Cheyenne, WY.

ZAFFT, D.J. AND E.A. BEAR. 2009. Guidelines for the collection of fish voucher specimens. Wyoming Game and Fish Department Administrative Report, Cheyenne, WY.